Force Practice Problems 4th Block 9.27.11

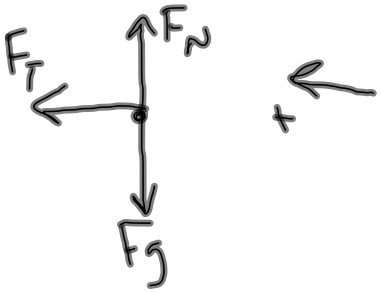
A dog (14.0 kg) and a monkey (8.0 kg) are playing tug-of-war on a frictionless surface. They are attached by a rope, and the dog pulls on the monkey's collar with a force of 55.5 N.

a) What happens to the motion of each animal?
b) Which animal receives the most force?
c) Calculate the acceleration of the monkey.

Dog → right
Monkey → left

→ the same

FBD Monkey:



c) $\sum F_x = m_m a$

$$a = \frac{\sum F_x}{m_m}$$

$$= \frac{F_T}{m_m}$$

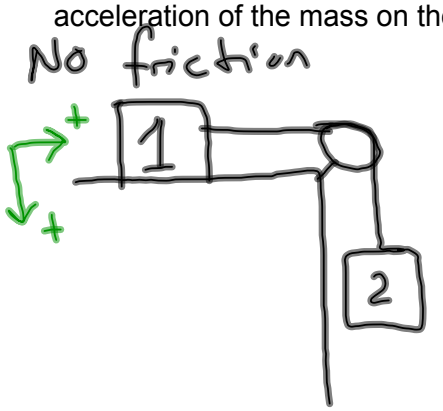
$$= \frac{55.5\ N}{8.0\ kg}$$

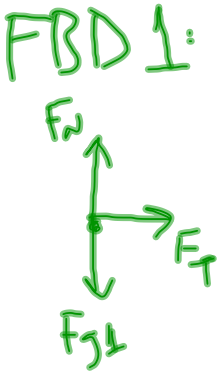
$$= 6.94\ m/s^2$$

"Tug-of-war" problem:

- each object experiences the same force
- if different masses, different accelerations

A block of mass 9.89 kg is on a horizontal surface and is attached to a block of mass 5.88 kg that is hanging by means of a rope passed over a pulley. Find the acceleration of the mass on the table.





$$\sum \bar{F}_{y2} = m_2 \bar{a} \qquad \sum \bar{F}_{x1} = m_1 \bar{a}$$

$$F_{g2} - \bar{F}_T = m_2 a \qquad F_T = m_1 a$$

$$F_{g2} = m_2 g$$

$$m_2 g - m_1 a = m_2 a$$

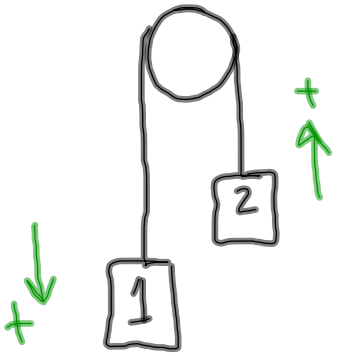
$$a(m_1 + m_2) = m_2 g$$

$$a = \frac{m_2 g}{(m_1 + m_2)}$$

$$= \frac{(5.88\ kg)(9.8\ m/s^2)}{(9.89\ kg + 5.88\ kg)}$$

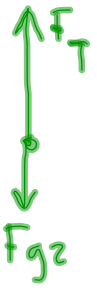
$$= 3.65\ m/s^2$$

Two masses are hanging by a rope passed over a pulley. The mass on the left is 7.89 kg, and the mass on the right is 6.87 kg. What is the acceleration of the block on the right?



FBD 1:

FBD 2:



$$\Sigma \bar{F}_{y1} = m_1 \bar{a} \qquad \Sigma \bar{F}_{y2} = m_2 \bar{a}$$

$F_{g1} = m_1 g$ $\qquad$ $F_{g2} = m_2 g$

$$F_{g1} - F_T = m_1 a \qquad F_T - F_{g2} = m_2 a$$

$$m_1 g - (m_2 g + m_2 a) = m_1 a \qquad F_T = m_2 g + m_2 a$$

$$a_g (m_1 - m_2) = a (m_1 + m_2)$$

$$a = \frac{g (m_1 - m_2)}{(m_1 + m_2)}$$

$$= \frac{(9.8\ m/s^2)(7.89\ kg - 6.87\ kg)}{(7.89\ kg + 6.87\ kg)}$$

$$= 0.677\ m/s^2$$

Pulley I problem → block table/block hanging
(1) (2)

$$a = \frac{m_2 a_g}{m_1 + m_2}$$ w/o friction

Eqns. → $\Sigma \bar{F} = m\bar{a}$ $F_g = ma_g$

$F_f = \mu F_N$

Pulley II problems → both masses hanging

$$a = \frac{a_g(m_1 - m_2)}{(m_1 + m_2)}$$

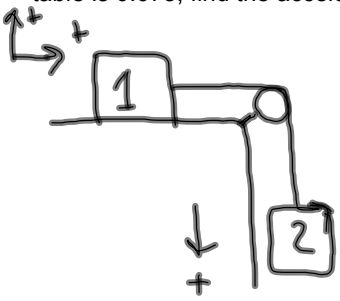
1 → left block
2 → right block

$m_1 > m_2$

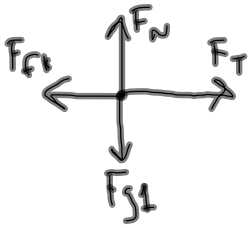
Pulley problems → accelerations are equal

Tug-of-war → force equal

A 12.5 kg block is on a table and is attached by means of a rope and pulley to a 9.55 kg block that is hanging. If the coefficient of friction between the block on the table and the table is 0.678, find the acceleration of the blocks.



FBD 1:



FBD 2:

$$\sum \bar{F}_{y2} = m_2 \bar{a} \qquad \sum \bar{F}_{x1} = m_1 a$$

$$F_{g2} - F_T = m_2 a \qquad F_T - F_{fk} = m_1 a$$

$$F_T = F_{fk} + m_1 a$$

$$= \mu_k F_N + m_1 a$$

$$m_2 a_g - (\mu_k m_1 a_g + m_1 a) = m_2 a$$

$$= \mu_k m_1 a_g + m_1 a$$

$$a_g (m_2 - \mu_k m_1) = a(m_1 + m_2)$$

$$a = \frac{a_g (m_2 - \mu_k m_1)}{(m_1 + m_2)}$$

$$\sum \bar{F}_{y1} = 0$$

$$F_N - F_{g1} = 0$$

$$F_N = F_{g1} = m_1 a_g$$

$$= \frac{(9.8\ m/s^2)[9.55\ kg - (.678)(12.5\ kg)]}{(9.55\ kg + 12.5\ kg)}$$

$$= 0.478\ m/s^2$$

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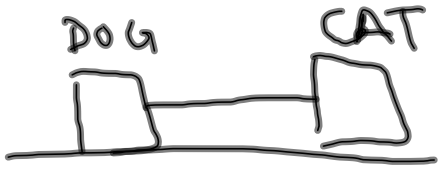
In a game of tug-o-war on a frictionless surface, a 120.0 N dog pulls on a 65.5 N cat, making the cat accelerate at 1.42 m/s/s. What is the acceleration of the dog?



$m_D = 12.23\ kg \quad m_C = 6.68\ kg$

$$\Sigma \bar{F}_C = m_C \bar{a}_C$$

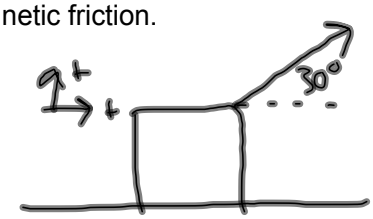
$$F_T = m_C a_C$$
$$= (6.68\ kg)(1.42\ m/s^2)$$
$$= 9.49\ N$$

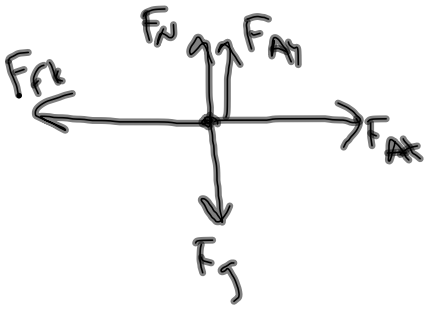
$$\Sigma \bar{F}_D = m_D \bar{a}_D$$

$$F_T = m_D a_D$$

$$a_D = \frac{F_T}{m_D}$$
$$= \frac{9.49\ N}{12.23\ kg}$$
$$= .775\ m/s^2$$

A block with mass 20 kg is pulled along a horizontal surface at constant velocity with a force of 100 N at an angle of 30 degrees above the horizontal. Find the coefficient of kinetic friction.





① $F_{fk} = \mu_k F_N$

$\mu_k = \frac{F_{fk}}{F_N}$

② $\Sigma \vec{F}_x = 0$

$F_{Ax} - F_{fk} = 0$

$F_{fk} = F_{Ax} = F_A \cos(30°)$

$= (100\,N)\cos(30°)$

$= 86.6\,N$

③ $\Sigma \vec{F}_y = 0$

$F_N + F_{Ay} - F_g = 0$

$F_N = F_g - F_{Ay}$

$= ma_g - F_A \sin(30°)$

$= (20\,kg)(9.8\,m/s^2) -$

$(100\,N)\sin(30°)$

$= 146\,N$

④ $= \frac{86.6\,N}{146\,N}$

$= 0.593$